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(54) METHOD AND APPARATUS FOR APPLYING PATTERNS TO OBJECTS

(71) We, KABUSHIKI KAISHA KOBAYASHI, a Japanese body corporate, of 156 Kotobukicho Isezakishi, Gunmaken, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a printing apparatus and to a method of applying a pattern to a surface of an object.

It is often required to apply patterns, such as wood grain patterns, to molded synthetic resin products such as cabinets for television sets, and vacuum cleaner housings, or to metallic products such as aluminium sashes. An apparatus which prints a wood grain pattern onto a surface of an object is known and uses an impression plate carying a wood grain pattern made from a phototype. However, this known wood grain pattern printing apparatus only permits the printing of patterns onto flat surfaces and as such is restricted in its use. It is often required to print patterns onto surfaces which are curved, protruded, concave or recessed.

In a further known apparatus a wood grain pattern which is made on a plate cylinder by a phototype is transferred onto a soft polyurethane roll which prints the pattern onto a surface of an object. With this apparatus printing onto curved surfaces is possible. However, this apparatus only prints patterns successfully onto surfaces having a relatively large curvature and printing onto uneven or recessed surfaces is difficult.

An apparatus is also known in which an irregular stripe pattern is prepared by dropping printing ink onto a water surface and is then transferred onto a surface of an object submerged in the water. However it is difficult and time consuming to form a suitable pattern on the water surface, and it is impossible to make the same stripe pattern each time, so that different patterns are printed on different objects and the stripe pattern actually transferred onto the object does not look like a wood grain pattern.

Further, a method in which objects are molded from a plurality of types of synthetic resins of different colours and brightness has been developed to produce objects having a wood grain pattern thereon. However, the pattern varies from object to object and the method cannot be used for objects which are not made from plastics materials.

It is an object of the present invention to provide a printing apparatus and a method of printing on the surfaces of objects in which the disadvantages described above are reduced.

According to a first aspect of the present invention there is provided a printing apparatus comprising means for printing a pattern onto a surface of a thin film, pattern transferring means including a reservoir for a liquid arranged such that the liquid has a surface for floating said thin film, means for transferring said thin film to said surface, and means for at least partially submerging an object in said liquid, whereby the pattern on the surface of the thin film is transferred onto the surface of the object by liquid pressure upon said at least partial submersion of said object in said liquid with the surface of said object to be printed in contact with the printed surface of said thin film, and, thin film removing means for removing said thin film from the surface of said object.

According to a further aspect of the present invention there is provided a method of applying a pattern to a surface of an object comprising the steps of printing the pattern onto a surface of a thin film, floating the thin film on a liquid, at least partially submerging the object in the liquid with the surface of the object to be printed in contact with the printed surface of the thin film whereby the pressure of the liquid

transfers the pattern to said surface of the object, and removing the thin film from said surface of said object.

Embodiments of the present invention will hereinafter be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a cross sectional view of a printing apparatus of the present invention;

Figure 2 is a perspective view of the printing apparatus showing a mechanism to permit floating of a thin film on the liquid;

Figure 3 is a cross sectional view showing an embodiment of pattern transferring means of the apparatus;

Figures 4 and 5 are cross sectional views illustrating the operation of the transferring means of Figure 3;

Figure 6 is a cross sectional view of an embodiment of the pattern transferring means which is provided with means to vary the angle of inclination of the object to be printed;

Figure 7 is a cross sectional view of an embodiment of thin film removing means of the printing apparatus;

Figure 8 is a plan view of the apparatus shown in Figure 7, and

Figure 9 is a cross sectional view showing an embodiment of pattern transferring means for use with a liquid metal.

Referring to Figure 1, there is shown the printing device 1 which prints a pattern such as, for example, wood grain pattern on the thin film 2 and the cutting device 3 which cuts the thin film 2, which is printed by said printing device, in the specified length.

Said printing device comprises plate cylinder 11 which is provided with a pattern such as wood grain pattern prepared by the phototype on its external periphery, inking roller 12 which rotates in contact with the plate cylinder to supply the ink to plate cylinder 11, ink reservoir 13 which supplies the ink to inking roller 12, impression cylinder 14 which can contact plate cylinder 11 and presses thin film 2 onto plate cylinder 11 to print the pattern on thin film 2 and doctor 15 which removes a surplus of the ink applied to the surface of said plate cylinder 11.

Said ink can be selected in accordance with the type of object and thin film to be printed and, in addition to so-called printing inks, paints and pigments can also be used.

Said impresion cylinder is made of a soft and elastic material such as, for example, polyurethane so that thin film 2 is depressed uniformly onto plate cylinder 11.

Thin film 2 is wound in the form of roll, held by holding roller 116, unwound from holding roller 16 and fed between plate cylinder 11 and impression cylinder 14.

Plate cylinder 11 is coupled to driving mechanism 17 through chain 17*a* and sprocket 17*b* so that it is ready to be rotated by said driving mechanism which incorporates a motor and gears and inking roller 12 is connected to plate cylinder 11 through gear 17*c*, intermediate gear 17*d* and chain 17*e* so that it may be rotated in contact with plate cylinder 11. Impresion cylinder 14 is provided with bearing 14*a* which is slidably mounted on frame 18 so that impression cylinder 14 moves between the position where it comes in contact with plate cylinder 11 and the position where it does not come in contact with plate cylinder 11, and said bearing 14*a* is depressed by depression roller 14*d* at the extreme end of lever 14*c* so that it is lifted and lowered by said lever 114*c* which is lever-actuated by liquid pressure cylinder 14*b*. Impression cylinder 14 is provided with gear 14*e* which can mesh with gear 17*c* of plate cylinder 11 so that it is rotated by said plate cylinder when it comes in contact with the plate cylinder.

When impression cylinder 14 is forced to contact plate cylinder 11 and to rotate by operation of liquid pressure cylinder 14*b*, thin film 2 is unwound from holding roller 16, printed between plate cylinder 11 and impression cylinder 14 and fed to cutting device 3 while printed surface 2*a* is faced up. Cutting device 3 is used to cut thin film 2 in the specified length and comprises film seizing slide 31 which seizes the end of thin film 2 and travels as long as specified in the direction to separate from said impression cylinder 14 to feed said thin film as long as specified, cutting section 32 which burns off or melts by heat said thin film 2 which is fed as long as specified by said film seizing slide 31 and seizing section 40 which seizes thin film 2 when it is cut.

Said cutting section 32 comprises resistance heat generating wire 32*a* such as a nichrome wire which is arranged to oppose one side of said thin film 2 and operating cylinder 32*b* which lowers said resistance heat generating wire to make it contact with one side surface of said thin film 2 when the thin film is cut.

Said film seizing slide 31 is devised to be reciprocated by chains 33 arranged at both sides of the slide in the direction of contact or separate from cutting section 32 and comprises sprocket 34 which is mounted to frame 31*a* of slide 31 so that said sprocket can move vertically and cannot rotate, lifting cylinder 35 which lifts and lowers said sprocket to engage sprocket 34 with said chain, rotatable guide roller 37 which is guided by guide frame 36, comb-shaped grip 38 which can seize the extreme end of thin film 2 and liquid pressure cylinders 39 which actuate said grip.

Sprocket 34 meshes with lower part 33*a* of chain 33 when it is lowered and meshes with

upper part 33*b* of chain 33 when it is lifted. Accordingly, the traveling direction of slide 31 is reversed when the sprocket is lifted or lowered.

Seizing section 40 is provided at a position slightly nearer print device 1 than the position of cutting section 32 and comprises gripping pieces 40*a* and 40*b* opposing both upper and lower surfaces of thin film 2 and operating cylinder 40*c* which lowers gripping piece 40*a* at the upper side when said thin film is cut. Accordingly, thin film 2 is held between both gripping pieces 40*a* anmd 40*b* when said thin film is cut and the thin film can be easily cut.

It is preferable to use a wet-expansible material such as, for example, a film which principally contains starch as said thin film as described in the following. In this case, the thin film has small mechanical tensile strength and expands or shrinks with variation of the temperature or humidity. Accordingly, it is preferable to move said slide 31 with thin film 2 which is not tautened and is slackened. For example, as shown in Figure 1, a pair of microswitches S1 and S2 which function when said thin film comes in contact with the microswitches are arranged with a certain vertical distance at the lower surface side of thin film 2 between said printing deviced 10 and cutting device, and driving mechanism 41 which drives said chain driving mechanism 41 which drives said chain 33 is provided with speed control mechanism 92 which varies the running speed of the chain, in other words, the speed of the slide.

Said speed control mechanism 92 is adapted to vary the running speed of the chain in three steps, for example, regular, high and low speeds, and to be changed over to the regular speed when upper microswitch S1 is functioning and lower microswitch S2 is not functioning, to the low speed when the amount of slackness of thin film 2 is decreased and upper microswitch S1 does not therefore function and to the high speed when the amount of slackness of thin film 2 is increased and lower microswitch S2 functions.

With this construction, thin film 2 is kept slightly slackened since it is positioned between upper and lower microswitches.

When impression cylinder 14 rotates keeping contact with plate cylinder 11, sprocket 34 engages with part 33*a* of chain 33 and slide 31 travels to the right in the diagram while grip 38 seizes the extreme end of thin film 2. When the slide reaches the specified position, impression cylinder 14 of the printing device separate from plate cylinder 11 with a signal from the microswitch, which is not shown, to cause the printing to stop, sprocket 34 of the slide is disengaged from chain 33 to stop slide 31, seizing section 40 operates to seize thin film 2 and resistance heat generating wire 32*a* of cutting section 32 is lowered to cut thin film 2. After this, resistance heat generating wire 32*a* lifts, grip 38 releases thin film 2 and thin film 2 is moved to a certain other place by the other means such as, for example, manual operation. When sprocket 34 engages with upper part 33*b* of said chain 33, slide 31 is returned to the left in the diagram and grip 38 seizes the extreme end of thin film 2 which is not yet cut.

The means to print on the thin film are not limited to the embodiment described above; for example, the means can be such that it permits printing on the thin film which is cut in advance in the specified length or that the thin film on which a pattern is continuously printed can be fed continuously to the transferring device without cutting.

In the embodiment, thin film 2 is fed to transferring device 5 after it has been cut in the specified length by cutting device 3.

Transferring device 5 comprises basin 51 which is open above the stores liquid 50 such as water or acid or alkaline solution.

Said thin film 2 with printed surface faced up is floated on liquid 50 in basin 51. The operation in the process from said cutting device 3 until said thin film is floated on liquid 50 can be performed manually or can be automated as shown in Figures 1 and 2.

In Figures 1 and 2, a pair of bent suction pipes 42 are provided at positions below thin film 2 fed by slide 31 of cutting device 3.

A plurality of suction ports 42*b* of suction pipes 42 are arranged in the lengthwise direction of horizontal suction section 42*a* which can come in contact with the lower surface of thin film 2 and are devised so that they are rotated to approach or separate from each other in reference to the horizontal axis below as much as the specified length from said thin film 2.

Said suction pipes 42 are provided with gears 43 at their one-side ends and said gears 43 are engaged with worm gears 44. Said worm gears 44 are mounted on common shaft 45 which is rotated by driving mechanism 47 which can rotate either in the forward direction or in the reverse direction such as a motor and are adapted to rotate said suction pipes in the opposite directions.

Suction means 46 such as vacuum pumps or air exhaust blowers are connected to other ends of said suction pipes.

When thin film 2 is fed to the cutting position by slide 31, suction pipes 42 are positioned at the highest positions so that their suction ports 42*b* oppose to the lower surface of thin film 2. When thin film 2 is cut and grip 38 releases thin film 2, suction means 46 operates to cause the lower surfaces of both end parts to cut thin film 2

to be sucked by suction ports 42*b*. When the suction pipes are rotated by the specified angle in the direction where the suction pipes approach each other, thin film 2 is drooped down at its central part as shown with a broken line in Figure 2.

Basin 51 which is open above is provided below suction pipes 42. Accordingly, the central drooped down part of thin film 2 floats on the surface of liquid 50.

After this, suction pipes 42 are forced to stop suction and return to the home position and entire thin film 2 is floated on the surface of liquid 50.

As described above, when thin film 2 is floated on the liquid as being drooped down at its central part, bubbles are prevented from remaining between said thin film 2 and the surface of said liquid 50.

When said thin film is floated on the liquid by holding it at its both ends, it is desirable to droop down the central part of said thin film.

Thin film 2 is preferably a wet-expansible material such as, for example, a wager like Oblaat which contains starch as the principal ingredient. In this case, thin film 2 absorbs the liquid to expand or extend when it is floated on liquid 50 and therefore the wrinkles of said thin film 2 disappear immediately even though the thin film has wrinkles.

Basin 51 storing liquid 50, as shown in Figure 3 is moved to the position of submerging means 7 which lowers object 6 to be printed against said thin film 2 from the above into liquid 50.

Basins 51 are radially arranged around vertical rotary shaft 53 and are moved from the position of said cutting device 3 to the position of said submerging means 7 by rotating said rotary shaft 53 with motor 54 and gear mechanism 55.

The means to submerge object 6 into liquid 50 can be freely formed, for example, as shown in Figure 3, the submerging means can comprise liquid pressure actuating cylinder 71 which lifts and lowers arm 72 which is projected at the side of the rod of said liquid pressure actuating cylinder and holding section 73 which is suspended from the extreme end of said arm 72 as a means to hold said object 6. Holding section 73 can be freely designed in accordance with the shape of object 6; for example, it can comprise rod 73*a* which is suspended from said arm 72 and bifurcated arms 73*b* and 73*b'* provided at the lower end of said rod 73*a* so that said bifurcated arms hold object 6 by depressing onto the inside walls of the object in case that said object 6 is a cabinet which is open above.

Object 6 is made to contact with printed surface 2*a* of thin film 2, further impressed onto printed surface 2*a* of thin film 2 and submerged into liquid by said submerging means 7 as shown in Figure 4 and 5. Accordingly, thin film 2 closely adheres to the surface of the object and the pattern of said printed surface 2*a* of thin film is transferred onto the surface of object 6.

Submergence of the object into the liquid by said submerging means can be as much as enough to submerge the surface to be printed of the object into the liquid and therefore the object need not be completely submerged into the liquid.

As said submerging means, object 6 can be submerged manually into the liquid.

For effective impression of object 6 onto thin film 2 and effective close adherence of thin film to the surface of object 6, it is desirable to submerge object 6 into liquid 50 while changing the angle of object 6 against the surface of liquid 50 as shown in Figure 6. Thus, thin film 2 gradually adheres close to the surface of the object as the object is rotated and air bubbles which may remain at unevent parts of the object can be removed by progress of gradual close adherence of said thin film. Accordingly, the means described above is especially effective for the objects with projections and grooves.

In Figure 6, gear 73*c* is provided at the body of vertical rod 73*a* which lifts and lowers, the eccentric part of said gear 73*c* and the extreme end of said bifurcated arms 73*b'* is connected by connecting rod 73*d* and rack 73*e* which engages with the gear when rod 73*a* is lowered is fixed. Bifurcated arms 73*b* and 73*b'* are mounted on said rod by pins 73*f* so that they can be simultaneously rotated.

When rod 73*a* lowers gear 73*c* engages with rack 73*e*, thereby the gear is rotated to rotate bifurcated arms 73*b* and 73*b'* and the angle of object 6 is varied.

As described above, after the pattern of thin film 2 has been transferred onto object 6, thin film 2 is removed from the surface of the object by thin film removing means 8 and the pattern thus remains on the object surface.

As shown in Figures 7 and 8, said thin film removing means 8 comprises curved thin film removing basin 81 which stores water and is open above, a plurality of hangers 82 to suspend object 6, lifting cylinders 84 which lift and lower arms 83 which support said hangers 82 and driving means 85 which rotates said arms 83 along said thin film removing basin 81.

Object 6 is submerged in thin film removing basin 81 by said lifting cylinder 84 as being suspended by said hangers 82 and drawn up from water in thin film removing basin 81 after having been kept submerged in water for a certain period of time.

Said water contains a bacterial α-amylase

as an enzyme to decompose a farinaceous thin film and therefore said farinaceous thin film 2 is decomposed and removed by action of said enzyme.

The temperature of said water may be from the room temperature to 70°C but it is preferably a warm water of 40°C to 60°C to promote the action of said enzyme. Submerging time of the object in the water containing the enzyme may be approximately 1 to 20 minutes of the thickness of farnaceous thin film 2 is approximately 20μ when it is not expanded.

It is desirable to provide a stirring means (not shown) to stir the water containing the enzyme in thin film removing basin 81 and, in this case, object 6 can be submerged in thin film removing basin 81 for about 1 to 5 minutes since decomposition of said thin film is promoted.

The concentration of the enzyme in the water may be 5 to 20% if the enzyme is α-amylase and approximately 10% is most preferable.

Object 6 drawn up from said thin film removing basin 81 is washed in water in the basin which is not shown thereby the enzyme is removed.

After washing, object 6 is preferably dried in the drying chamber which is not shown.

After this, it is preferable to apply a transparent covering material to the surface of object 6 so that the pattern printed on said object does not come off from object 6.

Hereupon, when the film 2 is made of a farinaceous material, the most desirable enzyme is α-amylase but the enzyme can be, for example, pepsin, trypsin, erepsin, glucose, fructose, etc. in accordance with the material of the thin film.

Moreover, thin film removing device 8 can be adapted to dissolve thin film 2 in a liquid which does not contain the enzyme.

In this case, though said liquid can be properly selected in accordance with the material of thin film 2, warm water can be used for a water-soluble thin film and an alkaline or acid solution can be used in accordance with solubility of the thin film.

Said thin film removing means can mechanically dissociate thin film 2. For example, if a fabric which is formed into a film with glue as thin film 2 is used, the thin film can be dissociated by dissolving the glue in warm water or the similar.

In case of dissolving or dissociating said thin film with a liquid, the liquid can be showered onto the surface of object 6. The liquid which can dissolve the thin film can be atomized and applied onto the thin film. Furthermore, in case that the thin film can be dissolved or separated by a special gas, the gas can act on the thin film.

If thin film 2 is made of a material which is melted at high temperatures, a means to heat said thin film can be used as the thin film removing means. If thin film 2 is made of a material which is destroyed at low temperatures, a means to treat said thin film 2 at low temperature can be used. Furthermore, a means to physically exfoliate thin film 2 from the object can be used.

Removal of the thin film can be finished after completion of the transferring. Accordingly, removal of the thin film can be commenced simultaneously with commencement of transferring. For example, when a liquid which can dissolve or dissociate the thin film is used as liquid 50, transfer and removal of the thin film can be performed simultaneously.

In this case, though the thin film begins to be dissolved at the same time the transferring process starts, the transferring is performed within an extremely short period of time and there is no actual hindrance.

If, for example, a water soluble polyvinyl alcohol is used as thin film 2, water or warm water can be used as liquid 50.

In case that a liquid which can dissolve the thin film is used as liquid 50, thin film removing device 8 as described in the embodiment can be provided to completely remove thin film 2 which has been removed to some extent in the transferring process.

In the above-stated embodiment in which farinaceous thin film 2 is used, if water of room temperature of approximately 20°C is used as liquid 50 of the transferring means, farinaceous thin film 2 is slightly dissolved in transferring process and completely removed by thin film removing deviced 8. However, when thin film removing device 8 is provided, liquid 50 need not always have a nature to dissolve said thin film.

Said thin film 2 preferably has excellent expansibility when it is floated on the surface of liquid 50 and excellent flexibility to ensure completely close adherence to uneven surfaces of the object to be printed. Particularly, in case the unevenness of the surface of the object is complex, the thin film preferably adheres closely to the uneven surface of the object while in the expanded state. Thus, the thin film preferably has excellent expansibility and flexibility when it is floated on liquid 50.

From this point of view, it is most preferable to use the farinaceous film as thin film 2. Use of the farinaceous thin film is more advantageous than use of a high molecular compound film in that the former will bring about far less public nuisance than the latter.

In addition, the materials of the thin film are polyacrylic acid soda, polyvinyl alcohol, methyl cellulose, carboxymethylcellulose, polyethylene oxide, polyvinylpyrolidone and acrylic acid amide as synthetic high molecular substances; glue, gelatin, casein

and polypeptide as animal high molecular substances; starch, cellulose, dextrin, albumin, soy bean protein, gum arabic and tragacanth gum as vegetable high molecular substances; and sea weed glue, Japanese gelatin and alginic acid soda as sea weed high molecular substances.

In said transferring means, a liquid metal can be used as the liquid to extend and support the thin film. In this case, transferring device 5 can comprise, for example, as shown in Figure 9 basin 57 provided with heating means 56 such as a heater or burner wherein a molten metal with low melting temperature is stored.

Wood's alloy, Rose's alloy or Newton's alloy can be used to make said liquid metal. Wood's alloy is an alloy with the melting point of 65°C to 70°C and a formulation approximate to that of a common compound consisting of four ingredients, Bi 50%, Pb 24 — 26%, Sn 12 — 14% and Cd 12 — 13%, and Rose's alloy and Newton's alloy are alloys with the melting points of approximately 95°C and a formulation approximately to that of a common compound consisting of three ingredients, Bi 50%, Pb 31% and Sn 19%. If a polyethylene film is used as thin film 2 it is softened and therefore the thin film well adheres close onto object 6 in transferring.

When the liquid metal is used as film supporting means of the transferring means, it has generally a large surface tension and it is easy to float thin film 2 on the surface of the liquid metal. Since liquid metals generally have large specific gravity, the liquid pressure to impress the thin film onto the surface of the object is large and therefore the printing effect on uneven surfaces is improved. Furthermore, the liquid metal generally has a considerably high temperature, transfer of the printing ink is promoted and clear printout is obtained.

If the liquid metal is used as the film supporting means, the thin film removing means is provided as the following process of the transferring process.

The apparatus in accordance with the present invention provides the following advantages.

Since the pattern to be printed is transferred by closely adhering the thin film onto the surface of the object utilizing the pressure of the liquid, printing is possible on any object with curved, recessed or projected surfaces.

Since the phototype technique can be used, realistic wood grain patterns can be printed on any object.

The same pattern can be printed on a number of objects.

The printing pattern is transferred onto the object and therefore the colours of a multi-color pattern can be printed on the object simultaneously.

WHAT WE CLAIM IS:—

1. A printing apparatus comprising means for printing a pattern onto a surface of a thin film, pattern transferring means including a reservoir for a liquid arranged such that the liquid has a surface for floating said thin film, means for transferring said thin film to said surface, and means for at least partially submerging an object in said liquid, whereby the pattern on the surface of the thin film is transferred onto the surface of the object by liquid pressure upon said at least partial submersion of said object in said liquid with the surface of said object to be printed in contact with the printed surface of said thin film, and, thin film removing means for removing said thin film from the surface of said object.

2. A printing apparatus as claimed in claim 1, wherein said reservoir comprises means for heating said liquid.

3. A printing apparatus as claimed in either preceding claim, wherein said thin film removing means is separate from said pattern transferring means.

4. A printing apparatus as claimed in claim 3, wherein said thin film removing means comprises means for showering a thin film dissolving liquid onto said object to which said thin film adheres.

5. A printing apparatus as claimed in claim 3, wherein said thin film removing means comprises means for atomizing a thin film dissolving liquid and spraying the atomized liquid onto said object to which said thin film adheres.

6. A printing apparatus as claimed in any of claims 1 to 3, wherein said thin film removing means comprises means to peel off said thin film from the surface of said object.

7. A printing apparatus as claimed in any of claims 1 to 3, wherein said thin film removing means comprises means for causing a gas which decomposes said thin film to act on said object.

8. A printing apparatus as claimed in any of claims 1 to 3, wherein said thin film removing means comprises means to produce an atmosphere which has a temperature so high as to melt said thin film to act on said thin film.

9. A printing apparatus as claimed in any of claims 1 to 3, wherein said thin film removing means comprises means to produce an atmosphere which has a temperature as high as to exfoliate said thin film to act on said thin film.

10. A printing apparatus as claimed in any preceding claim, wherein said pattern transferring means comprises means for submerging said object into said liquid

whilst changing the angle said object makes with the surface of said liquid.

11. A printing apparatus as claimed in any preceding claim, wherein said pattern transferring means further comprises medans for holding said object and lifting means for lifting and lowering said holding means whereby said object is brought into contact with the thin film afloat on the surface of said liquid and is submerged into the liquid by movement of said lifting means.

12. A printing apparatus as claimed in any preceding claim, wherein said pattern transferring means comprises film floating means to lower the thin film from above the surface of said liquid in said reservoir and to float said thin film onto the surface of the liquid.

13. A printing apparatus as claimed in claim 12, wherein said film floating means comprises supporting means for supporting both ends of said thin film, said supporting means being adapted to permit floating of the central part of said thin film on the surface of said liquid while said central part is kept drooped down and to release both ends of said thin film to float the entire thin film on the surface of the liquid.

14. A printing apparatus as claimed in any preceding claim, wherein said printing means comprises holding means for holding a roll of said thin film, a printing mechanism which continuously prints thin film unwound from said roll and cutting means which cuts the printed thin film into predetermined lengths.

15. A printing apparatus as claimed in claim 14, wherein detecting means for detecting slackness of said thin film due to its weight is provided between said cutting means and said printing mechanism to adjust a feed rate of the thin film so that the slackness of said thin film is controlled within a predetermined range.

16. A printing apparatus substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

17. A method of applying a pattern to a surface of an object comprising the steps of printing the pattern onto a surface of a thin film, floating the thin film on a liquid, at least partially submerging the object in the liquid with the surface of the object to be printed in contact with the printed surface of the thin film whereby the pressure of the liquid transfers the pattern to said surface of the object, and removing the thin film from said surface of said object.

18. A method as claimed in claim 17, wherein said liquid contains water.

19. A method as claimed in claim 18, wherein said thin film is of a material which expands when exposed to water.

20. A method as claimed in claim 19, wherein said thin film is made of a farinaceous material.

21. A method as claimed in claim 17, wherein said liquid is a liquid metal.

22. A method as claimed in claim 17, wherein removal of the thin film from the object is commenced after completion of the transfer of said pattern.

23. A method as claimed in any of claims 17 to 21, wherein said liquid includes said thin film removing means which acts to dissolve said thin film whereby removal of said thin film from the object is commenced when the transfer of the pattern to the object is commenced and completed when the transfer is completed.

24. A method as claimed in any of claims 17 to 23, wherein said thin film removing means comprises a liquid which dissolves said thin film.

25. A method as claimed in any of claim 17 to 23, wherein said thin film removing means comprises means for decomposing said thin film.

26. A method as claimed in claim 25, wherein said means for decomposing said thin film comprises a starch decomposing enzyme.

27. A method of applying a pattern to a surface of an object substantially as hereinbefore described with reference to the accompanying drawings.

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5 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

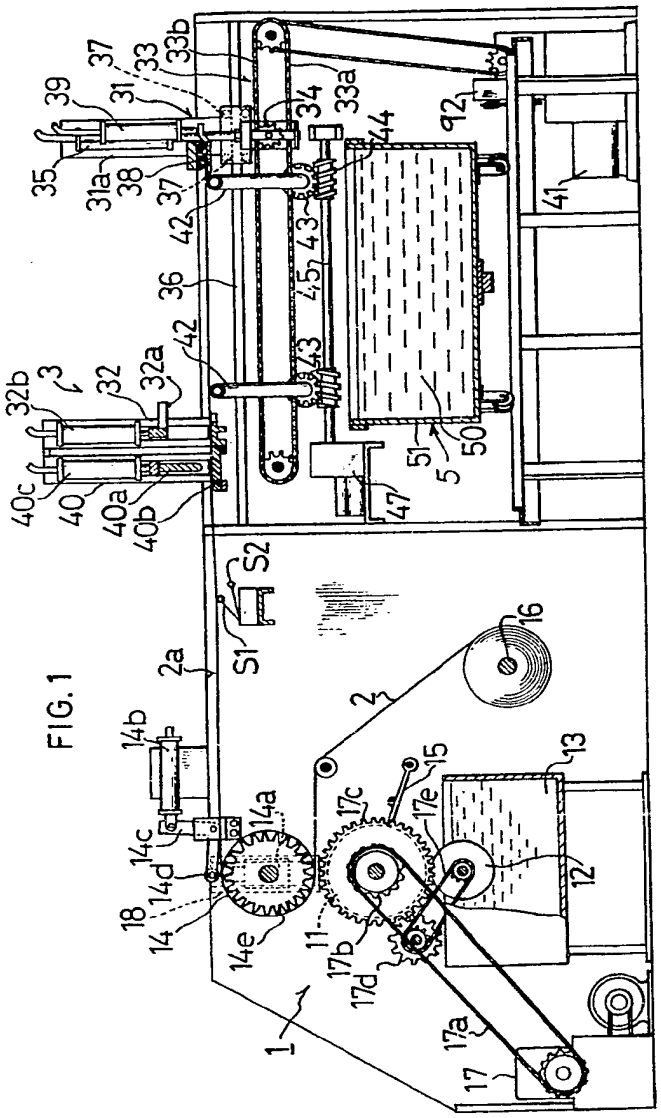

FIG. 1

FIG. 2

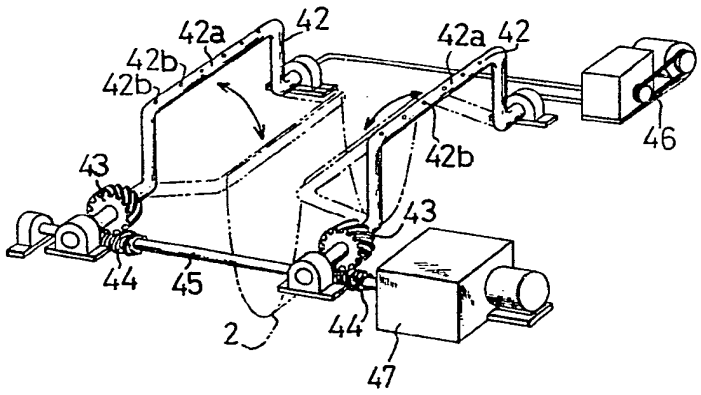

FIG. 3

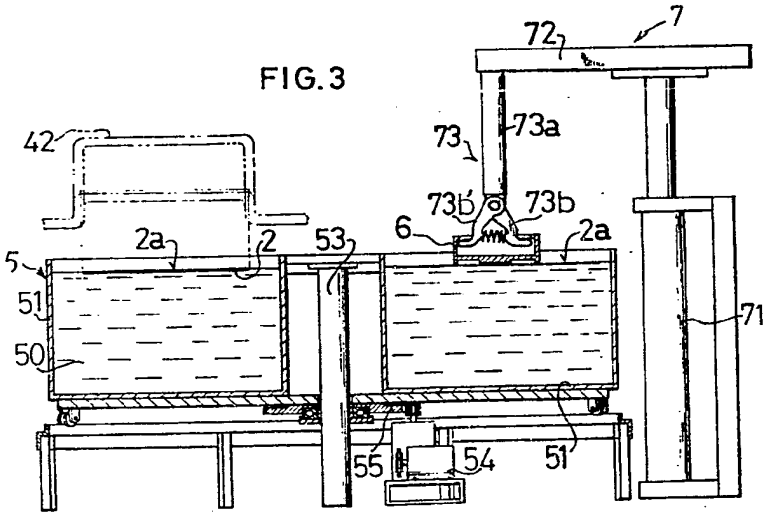

FIG.4

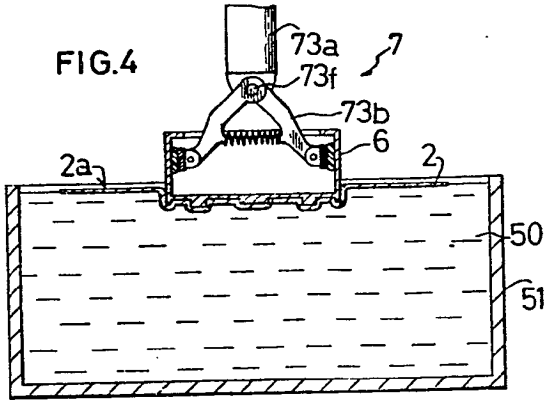

FIG.5

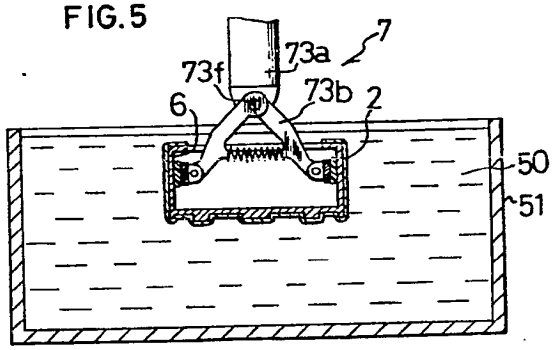

FIG.6

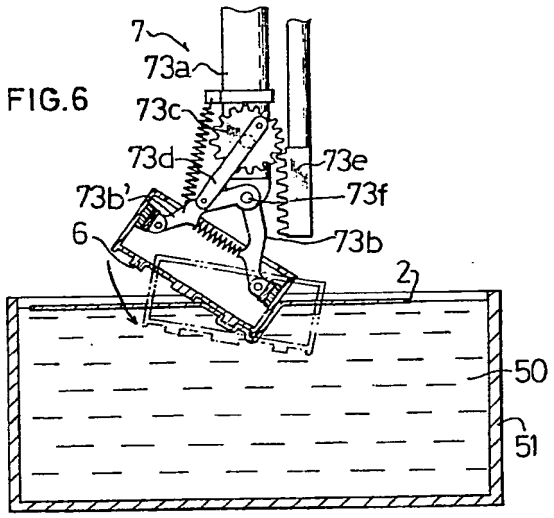

FIG. 7

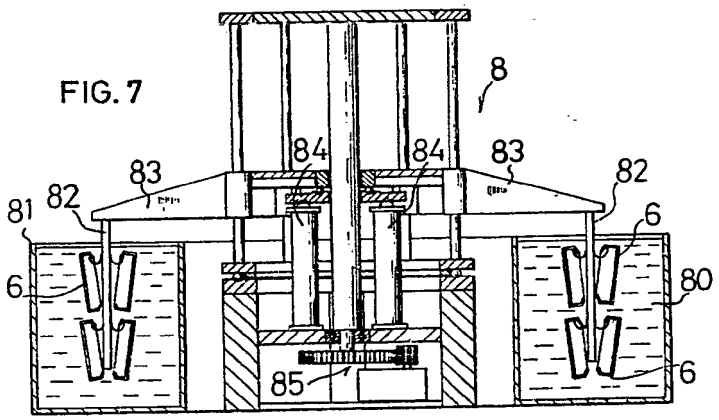

FIG. 8

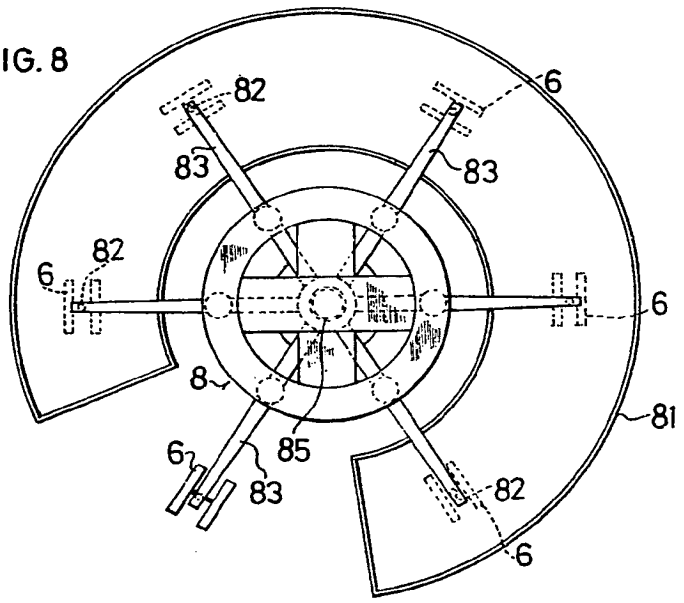

FIG. 9